Fall 2019

ME 231-001: Kinematics of Machinery

Ian S. Fischer

COURSE NUMBER	**ME 231**
COURSE TITLE	**Kinematics of Machinery**
COURSE STRUCTURE	(3-0-3) (lecture hr/wk - lab hr/wk – course credits)
COURSE COORDINATOR	Dr. Ian S. Fischer
COURSE DESCRIPTION	Design, selection, and evaluation of mechanisms for various applications. Topics include displacement, velocity, and acceleration analysis of planar linkages, synthesis of function generators and motion generators, design of cams, gear-tooth geometry, and analysis of gear trains
PREREQUISITE(S)	CIS 101 computer programming, Mech 234 statics
COREQUISITE(S)	None
REQUIRED, ELECTIVE OR SELECTIVE ELECTIVE	Required
REQUIRED MATERIALS	Robert L. Norton *Design of Machinery* McGraw-Hill, 6th ed., ISBN 978-1-260-22442-0
OTHER SUPPLEMENTAL MATERIALS (NOT REQUIRED)	none
COMPUTER USAGE	Matlab demonstrations
COURSE LEARNING OUTCOMES[1]	By the end of the course students should be able to: 1. Calculate the degree of freedom of a mechanism (a, c). 2. Identify the mobility of a four-bar mechanism (a, c). 3. Calculate the extremes of the transmission angle in a crank-and-rocker mechanism (a, c) 4. Calculate the displacements of a planar mechanism (a, c, e, k, n). 5. Apply Freudenstein's Equation in the analysis of a four-bar mechanism (a, c, e, k, n). 6. Synthesize a four-bar mechanism motion generator for two or three positions of a moving plane (a, c, e, k, n). 7. Synthesize a four-bar mechanism function generator for three precision points using Freudenstein's equation (a, c, e, k, n) 8. Calculate the velocities of planar mechanism (a, c, e, k, l, n). 9. Calculate the accelerations of planar mechanism (a, c, e, k, l, n). 10. Design a cam for a specified follower motion (a, c, e, k, l, n). 11. Design a gear train for a desired speed ratio (a, c, e, l) 12. Calculate the speed ratio of a planetary gear train (a, c, e, k, m)

CLASS TOPICS	1. Mechanisms and Machines – degrees of freedom, Grashof's rule, transmission angle, limiting positions (4 hours) 2. Displacement analysis (6 hours) 3. Linkage synthesis (6 hours) 4. Velocity analysis (5 hours) 5. Acceleration analysis (4 hours) 6. Cams – displacement, velocity, acceleration and jerk analysis of cam follower motion, polynomial cams (4 hours) 7. Spur gears, gear terminology, speed ratios (3 hours)
	8. Involutometry (3 hours) 9. Planetary gear trains (1 hour) 10. Exams (6 hours)
RELATED STUDENT OUTCOMES	The Course Learning Outcomes support the achievement of the following ME Student Outcomes of ABET Criterion 3 requirements **Outcome a** - An ability to apply knowledge of mathematics, science and engineering. **Related CLO** – [1]-12 **Outcome c -** An ability to design a system, component, or process to meet desired needs within realistic constraints such as economics, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. **Related CLO** – 1-12 **Outcome e -** An ability to identify, formulate, and solve engineering problems **Related CLO** – 4-12 **Outcome k** - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice **Related CLO –** 4-10, 12 **Outcome l -** Knowledge of chemistry and calculus-based physics with depth in at least one **Related CLO –** 8, 9, 10 (physics only) **Outcome m -** An ability to apply advanced mathematics through multivariate calculus and differential equations **Related CLO –** 12 (graph theory)

[1] Lower case letters in parenthesis refer to ABET Criterion 3: student outcomes (a-k)

ME 231
Kinematics of Machinery

Text:
Robert L. Norton *Design of Machinery* McGraw-Hill, 6th ed., ISBN 978-1-260-22442-0
The 5th edition of this text book can also be used.

Topics	**Reading 5th ed**	**Reading 6th ed**	**Problems 5th ed and 6th ed**
Introduction Degree of Freedom Grashof's Rule	Ch.1 pp.3-29, Ch.2 pp.30-95	Ch.1 pp.3-29, Ch.2 pp.30-97	2-15,18,22,32,39
Displacement Analysis	Ch.4 pp.174-227	Ch.4 pp.178-232	4-2,7,10,12
Linkage Synthesis	Ch.5 pp.228-284	Ch.5 pp.233-290	5-8,12,16,21,27
Velocity Analysis	Ch.6 pp.285-349	Ch.6 pp.291-356	6-5,7,8,16c,18c
Acceleration Analysis	Ch.7 pp.350-400	Ch.7 pp.357-408	7-4,6,7,8,15b
Cam Design	Ch.8 pp.401-481	Ch.8 pp.409-489	8-7,8,10,12,13,18
Spur Gears	Ch.9 pp.482-503	Ch.9 pp.490-511	9-1,3,4,5
Gear Trains	Ch.9 pp.503-541	Ch.9 pp.511-550	9-6,10,14,26,36,40,57

Problems have the same wording both editions, but there may be different values of the problem parameters.

19F/ISF

Supplement to Syllabus and Assignment Sheet for Dr. Fischer's Section of ME 231

Syllabus and Assignment Sheet. The syllabus and assignment sheet for all ME prefix courses are posted in the department website at link https://mie.njit.edu/students/me-required.php.

Textbook. Robert L. Norton *Design of Machinery* McGraw-Hill, 6th ed., ISBN 978-1-260-22442-0

First Examination. The first examination will be primarily concerned with but not limited to introductory topics, Grübler's equation, Grashof's Rule, transmission angle, and displacement analysis. The first examination will be held shortly after the lectures on those topics have been concluded.

Second Examination. The second examination will be concerned with Freudenstein's equation, synthesis of function generators, synthesis of motion generators, velocity analysis, and other topics including those which were on the first examination. The second examination will be held shortly after the lectures on those topics have been concluded.

Third Examination. The third examination will be concerned with acceleration analysis, cams, gear trains, gear-tooth geometry, and other topics including those which were on the first examination and second examination. The third examination will be held at the time and place scheduled by the Registrar for the "final" examination.

Final Grade. The final grade for the course will be based on average grade of the three examinations weighted equally.

Appeals. All appeals of grades must be submitted in class during the week after the examination has been returned, and in writing, signed and dated. The appeal of examination and course grades is discouraged.

Attendance. Students are expected to attend all of their classes. Absence at examinations is tolerated only in serious circumstances which have been properly documented according to university policy, and any of an imputed grade, make-up examination, or zero grade might be given as considered appropriate to the case at hand.

Punctuality. Students are expected to arrive for class on time and to be seated and ready before the professor enters the classroom.

Cheating. Students are expected to abide by the university policy on academic integrity.

Conduct. Students are expected to conduct themselves in a manner consistent with the civility objective of the 2020 plan.

Office Hour. Students may call on Dr. Fischer for help or guidance with the subject matter of the course only during 3-4pm on that day of the week when he has an evening class. This day depends on his class schedule which can change from semester to semester for which the student is referred to the course schedule in the registrar's website.

Disclaimer. This is not the offer of a contract. The syllabus, assignment sheet, textbook, grading, and all other policies and procedures are subject to change at any time and without notice. The scheduling of classes and examinations is subject to change because of weather and other conditions.